

Neck and Shoulder Pain

ALBERT FIELDS, M.D., and JOHN HOESLEY, M.D., *Los Angeles*

SUMMARY

Neck and shoulder pains are presenting or incidental symptoms in a large variety of conditions.

There may be similarities in the anatomico-physiological mechanism of pain production and in the clinical picture in many of these conditions.

Many of the vague and refractory cases of neck and shoulder pain and of migraine may be due to cervical disc disease.

Scalenus anticus syndrome and cardiac disease can be diagnosed or differentiated from cervical disc syndrome only by thorough investigation.

Proper treatment of neck and shoulder pain is dependent upon correct diagnosis through complete history, physical examination and laboratory tests, as described in this presentation.

IN the differential diagnosis of pain in the neck and shoulder, experience may be fallacious and judgment difficult. The pain may be simply an annoyance or a symptom of serious disease. Too often, because of inadequate examination and incomplete diagnosis, the patient receives everything from aspirin to balneotherapy, from colonic lavage to dental extraction, diathermy, diets, vitamins and/or operation. These patients wander from physician to physician, and often to cultists—and still the pain persists.

In some instances pain is present in one shoulder only; in others it may be bilateral or associated with neck pain on one or both sides. These multiple pains may be unrelated or they may result from the same underlying process. Opinion as to the frequency of various causes varies with the source of the opinion. The orthopedist, cardiologist, neurosurgeon and physician in general practice present different statistics.

SCALENUS ANTICUS SYNDROME

The syndrome of pain and altered sensation in the neck, shoulder, and C8-T1 dermatomes due to scalenus anticus hypertrophy and spasticity was described by Ochsner, Gage, and DeBakey²⁹ in 1934. These changes may be associated with vascular and vasomotor phenomena, and/or muscle weakness sometimes amounting to complete paralysis of the extensor muscles of fingers and wrist.

It is probable that any disease process of the cervical spine or shoulder region may produce secondary spasm of the scalenus anticus with resultant

compression of the subclavian and possibly brachial plexus, subclavian vein and sympathetic trunk. Elevation of the first rib resulting from this muscle spasm may further increase the pressure on these structures. Several interesting theories have been put forward to explain the muscle spasm, pain, and other symptoms. Todd³⁹ suggests that high fixation of the first rib due to inadequate descent of the sternum results in brachial plexus irritation; while Jones¹⁷ believes that the first rib compresses the dorsal nerves joining the lower cord of the brachial plexus. Aynesworth⁴ states that traumatic myositis is the chief factor in the production of spasm. Swank and Simeone³⁷ speak of an upper type in which there is pressure by the scalenus anticus tendons on the nerve roots of C5-6-7; and a lower type where there is a "squeeze" of C8 and T1 cords by the scalenus anticus and medius muscles. Gage¹² and his group support this last concept, basing their support on anatomical studies. However, Nachlas²⁷ and others feel that in most cases the scalenus anticus syndrome is secondary to cervical intervertebral disc abnormalities.

It is usually possible to differentiate clinically between the so-called upper and lower types of scalenus syndrome, as described by Swank and Simeone.³⁷ The more common lower type presents signs and symptoms due primarily to pressure on C8 and T1 roots and is characterized by the gradual onset of pain, muscle weakness and paresthesia. Mild to severe neck pain aggravated by pressure on the scalenus anticus is a constant finding; less commonly, pain along the medial-ulnar aspect of arm, forearm, hand, and ring and little fingers is present. Paresthesia, numbness, and diminished sensation to light touch and pin prick are found in the same regions. Weakness and atrophy of the intrinsic muscles of hand, ring and little fingers may be present. Sphygmomanometric readings show a diminution in arterial pulsations of the arm. Because obliteration of the radial pulse on turning the head to the affected side appears often in normal persons, this sign is not of diagnostic value.

The injection of novocain into the muscle usually relieves the spasm, pain, and other associated symptoms.¹⁸

The manifestations of the upper type of anticus syndrome are due to irritation of C6-7 roots with sudden severe weakness of the extensors of the wrist and fingers with paresthesia and reduced sensitivity of the thumb and index fingers, without pain or muscle spasm. Some patients do not have muscle weakness or sensory change, but muscle spasm and pain predominate in certain areas—namely, neck, tip of shoulder, posterior axillary fold, dorsum of upper arm, and extensor surface of the forearm.

Careful examination, and especially the novocain test, will differentiate between scalenus spasm, the syndromes described by Wright⁴⁶ (pectoralis minor pressure), by Falconer and Weddell¹⁰ (costoclavicular narrowing), and Raynaud's syndrome.

Irrespective of etiological concepts of the syndrome, conservative therapy is indicated and usually gives relief. Rest of the upper extremity, correction of poor posture,⁴⁰ change of occupation, massage, and novocain injection¹⁸ should be tried. Diathermy is recommended by Griffith.¹³ Nachlas²⁷ obtained relief for many patients by traction on the cervical spine by the use of either a halter or tongs. The authors have observed good results with this technique.

Scalenotomy, introduced by Naffziger²⁸ in 1934, is too often unsuccessful. It will not eliminate pain and paresthesia resulting from disc disease, but only that caused by vascular disorders due to compression of the subclavian artery by the spastic, hypertrophied muscle. Before scalenotomy is undertaken, disease of the intervertebral discs must be ruled out.³⁰

CERVICAL RIB

Lister was one of the first to excise a cervical rib. In 1905, the cervical rib syndrome was described by Murphy,²⁶ and in 1927 Adson and Coffey¹ relieved the pain and associated symptoms in this condition by scalenotomy.

Cervical rib, or elongated transverse process of C7 vertebra, the presence of which often is determined by routine roentgen examination, usually does not produce shoulder pain or other abnormal findings. In some cases there may be actual pressure by the cervical rib or enlarged transverse process on the brachial plexus and/or subclavian artery, producing a symptom-complex similar to that of scalenus syndrome.⁸ In these few cases, scalenotomy or excision of the rib may give relief, but this will be unavailing in cases in which symptoms are due primarily to disease of the discs.³⁰

CERVICAL DISC SYNDROME

Following the classical work of Schmorl, in 1928 Stookey³⁶ described cervical disc herniation, reporting six cases with cord compression and one with nerve root compression. Hawk¹⁴ in 1936 was able to find reports of only 36 such cases in the entire literature. However, in recent years, many cases have been reported. Saunders and Inman,³¹ in work on cadavers, found a high percentage with some degree of posterior herniation. The ratio of cervical disc herniation to lumbar disc herniation has been reported by Naffziger and Boldrey²⁸ at about 2-3:100. At Walter Reed General Hospital in a nine-month period, there were 143 herniated lumbar and 12 (8.3 per cent) cervical discs. The statistics of Raney³⁰ at Los Angeles County General Hospital favor the higher percentage.

The intervertebral disc in the cervical region is anatomically analogous to that in the lumbar region and is subject to the same changes. Although the

cervical discs support less weight and are subject to less trauma, they are narrower and more delicately constructed and are involved in a greater range of mobility.³⁸ As in the lumbar spine, herniations are most common at the level of greatest strain and through the weakest point in the annulus.²⁹ Discs 5 and 6 are usually involved with posterolateral herniations. Since the cervical canal is more nearly filled with nerve tissue than either the dorsal or lumbar region, even a small intraspinal mass causes earlier and more localized symptoms. The cervical root emerges from the dura to enter the intervertebral foramen at a right angle and lies immediately over the corresponding intervertebral disc. Thus the root may be compressed against the ligamentum flavum, pedicle, lamina, or facet by a posterolateral protrusion of the disc without involvement of the spinal cord.

Midline protrusions with pressure on the cervical cord present a picture likely to be confused with that of intraspinal neoplasms. In these cases the patients frequently give a history of minor trauma such as the sudden stopping of an automobile or a fall, followed by recurring neck stiffness, and pain in shoulders and arms aggravated by sudden movement of the head and neck. There is often tenderness over the spinous process at the level of protrusion, increased protein in the spinal fluid, and partial block as revealed by myelography. In this condition, prompt surgical operation is required. Of interest is another complication of disc displacement reported by Kahn,²¹ who presented three cases with the denticulate ligament traction and resultant damage to the lateral columns causing lateral sclerosis.

Posterolateral protrusion of the disc causing pressure on the cervical roots, without cord involvement, is being more frequently recognized as a cause of neck and shoulder pain. As has been said, this was formerly diagnosed as scalenus anticus syndrome, and scalenotomy was ineffective. Semmes and Murphey³³ have presented a clear description of this condition. Trauma is not an essential precursor. The usual history is that of stiffness of the neck and pain for months or years.⁹ The pain may be cervical, shoulder tip, between the scapulae, precordial, or across the chest.¹¹ It may be suboccipital and be diagnosed as "migraine."³⁰ Sudden extension of the neck, coughing, sneezing, or straining may aggravate the pain and produce an "electric shock" pain shooting into the little finger of the affected side. There may be numbness and paresthesia of the thumb, index, and middle finger which are more aggravating than the pain. Often the pain and paresthesia are made worse when the patient remains in one position for any length of time. Such a patient may have to get out of bed and walk about several times during the night in an effort to obtain relief. There may be associated vascular symptoms manifested by numbness, coldness, and blueness due to subclavian artery compression by the scalenus anticus, reflexly in spasm because of root irritation.

The patient usually holds the affected shoulder

elevated, and the head tilted forward or toward the unaffected side. There may be spinal tenderness at the site of the lesion; and percussion on the painful side, just lateral to the cervical spines, may reproduce the symptoms. Tilting the head and neck toward the painful side, "neck compression test," and pressure on the head will intensify the pain, whereas tilting away from the painful side, or traction, will relieve the symptoms. In many cases there are tenderness, weakness, or wasting of the pectoralis major, triceps, and extensors of the wrist and fingers. Roentgenograms will show a straightening of the involved region with absence of normal cervical lordosis, and diminution of intervertebral distance.⁴⁴ Oblique views may show narrowing of the intervertebral foramen with osteophyte formation. However, these findings are not pathognomonic. Myelography is advocated by most workers to verify the diagnosis.

In cervical disc herniation, with root compression only, conservative therapy in the form of halter traction may give permanent relief.³⁰ If the patient is comfortable in traction, but the pain recurs mildly when weight-bearing is resumed, Spurling³⁴ suggests a well-fitting cervical collar. Forcible manipulation in the presence of disc herniation is a dangerous procedure. There have been several recent reports of permanent damage to the cord due to manipulations. If there is pressure on the cord, or if the lesion is suspected of being a large one, or if pain and muscle spasm persist after several days of traction, operation is indicated. Recovery after operation is more complete and more rapid than for patients operated upon for lumbar disc herniation.

CERVICAL ARTHRITIS

Uncomplicated cervical arthritis is an uncommon cause of neck and shoulder pain. Of greater significance is nerve root pressure due to narrowed intervertebral foramina secondary to arthritis. These bony changes may be a generalized process due to old age or to rheumatoid arthritis, or, more commonly, to a local condition resulting from a damaged intervertebral disc. Keyes and Compere²² in 1932 described this latter condition and reproduced the lesions experimentally in dogs. Turner and Oppenheimer⁴² of Beirut in 1936 reported 50 such cases. Faulty posture may produce muscle-ligamentous strain in the cervical region⁴⁰ and predispose to chronic arthritis. The influence of local trauma and therapy has been discussed under cervical disc syndrome.

NEURITIS AND "RHEUMATISM"

For want of a better diagnosis, neck and shoulder pain is often labeled by the physician as neuritis, neuralgia, fibromyositis, or "rheumatism." The terms neuritis and neuronitis should be reserved for a specific entity of nerve inflammation due to trauma, toxic absorption, infection or metabolic disease. Pain and tenderness may be elicited along the course of nerves and the symptoms are not aggravated by head and neck motion. Brachial neu-

ritis may also occur secondary to cervical disc disease, osteoarthritis of the dorsal or cervical spine, scalenus anticus spasm or hypertrophy,¹⁹ cervical rib, or intraspinal lesions. Some of these conditions are considered elsewhere in this presentation. With "rheumatism" there is usually tenderness of the involved muscles as well as in other areas. Pain and the extent of disability are often difficult to evaluate and psychogenic possibilities must be considered. Elimination of focal infections is usually of little value. Salicylates, large doses of thiamin, massage, diathermy, or novocain infiltration sometimes gives relief. Work with poliomyelitis indicates that curare in oil³² or neostigmine²⁰ may prove of value in these cases.

BURSITIS

The most common cause of isolated shoulder pain is probably subacromial bursitis secondary to lesions of adjacent capsule, tendon or joint. Rupture or calcification of the supraspinatus tendon is often the primary lesion. Armstrong² collected reports of 89 such cases and described three cardinal signs: (1) a painful area between 60 and 120 degrees on abduction of the humerus, due to impingement of supraspinatus tendon of the covering bursa against the overlying acromium; (2) reversal of normal scapulohumeral rhythm due to reflex muscle spasm; (3) tenderness on deep pressure over the supraspinatus tendon. Toumey⁴¹ has pointed out that the pain is worse at night and may affect arm, scapular region, and neck. The pain may lead to disuse, adhesions, muscle atrophy, and limitation of movement. Codman⁷ believes that the bursa is more sensitive to pain than any of the surrounding structures. Surprisingly little is found at surgical operation in these cases even in the so-called "frozen" shoulder (peri-arthritis, or tendinitis).⁴⁵

In most cases, bursitis, even with calcification in bursa or tendon, responds to conservative therapy.⁴⁵ This does not mean immobilization in abduction, which leads to adhesions. Heat, curare,²⁰ diathermy, regulated exercises, and roentgen therapy have their advocates. Novocain or saline infiltration, especially by the two-needle technique, should be tried. Manipulation under anesthesia or the hyperabduction treatment of Codman⁷ may be necessary for breaking down adhesions. Wilson⁴⁵ favors manipulation after procaine infiltration of the bursa, followed by diathermy. Large calcifications may necessitate excision. Armstrong² stated that one-third of his patients required acromionectomy, but this appears to the authors to be unwarranted except in a few selected cases. Stellate ganglion block often gives relief when other measures have failed.⁶

CORONARY INSUFFICIENCY

In coronary artery disease or in myocardial infarction, pain in the neck or in either shoulder may occur with or without substernal distress. The origin of pain in coronary insufficiency appears to be due to lack of oxygen in the heart muscle. In the usual case of angina pectoris or of myocardial infarction the source of the shoulder pain is obvious. A more

difficult problem is encountered when shoulder pain is the only symptom of coronary artery disease or when shoulder pain occurs as a sequel to myocardial infarction. In the former situation the true cause of the pain may not be suspected; and in the latter the relationship between the infarction and the subsequent shoulder disability is usually misinterpreted as being coincidental.

The exact route for cardiac pain impulses has not been established. Probably most of the impulses are transmitted by way of the middle and inferior cardiac nerves to the cervical ganglia, down the sympathetic chain through the white rami communicantes and dorsal roots to the cord levels of T1 to T4. These impulses are transmitted up the cord by the lateral spinothalamic tract of the opposite side to the thalamus and cortex. In the cord, perhaps in the substantia gelatinosa or possibly in the dorsal roots, the cardiac pain impulses are projected to the dermatomes of the related afferent somatic nerves. Areas represented by these dermatomes include the precordial and pectoral regions, the inner aspect of the left arm and forearm down to the tip of the little finger, and the ulnar side of the ring finger.

The most acceptable explanation of shoulder pain in these cases is that of overflow of impulses, or accessory visceral or somatic neurons. The existence of accessory pathways has been suggested by the studies of White,⁴³ and others. As Heinbecker¹⁵ pointed out, painful impulses may be carried from the cardiac plexuses by accessory afferent sympathetic fibers to the cervical cord and referred to the shoulder region to which the cord is linked through nerves. According to Miller,²⁵ accessory afferent somatic fibers may exist in the lower cervical nerves and gain entry into C8 and T1 segments of the cord; thereby, the shoulder is brought into relation with a common intraspinal zone for the mediation of cardiac pain. This bidirectional conduction explains the occasional bizarre transmission from the shoulder dermatome into the precordium and the possibility of simulating "angina pectoris" by stimulation anywhere along the course of the involved nerves. Leriche²³ reproduced precordial pain by electrical stimulation of the left stellate ganglion. Bauer⁵ goes so far as to state that certain cases reported as herniation of lower cervical discs simulating angina pectoris were true cases of angina pectoris. Imperati and his co-workers¹⁶ reported two such cases, ascribing the pain to cervical arthritis secondary to disc disease. Libman²⁴ wrote of "re-bounds in the autonomic nervous system." He attributed shoulder pain following myocardial infarction to a "gouty state" resulting from lipoid metabolic disturbance and hepatic dysfunction which he considered basic in coronary artery disease and coronary thrombosis. Such a concept might explain the right shoulder, right hip, and ankle pain in several cases observed by the authors. Askey³ and others favor this explanation of local changes and a causalgia-like state.

In angina pectoris, shoulder pain,³⁴ which may be the sole symptom, is usually aching in character and

of short duration. It may be precipitated by undue exertion, excesses of eating or drinking, or emotional disturbances. It is relieved by the same measures which control substernal pain of angina pectoris.

Shoulder pain may occur simultaneously with myocardial infarction or it may appear days to weeks after the acute stage of the disease. Initially the pain may be severe, requiring sedation for relief; more commonly the patient will complain of distress only on abduction or internal rotation of the arm. In fact, the shoulder discomfort may be minimal and the clinician unaware of its presence unless the patient is carefully questioned. Pain and disability may persist for months, and the prognosis is uncertain, although outcome is favorable in the usual case. In cases reported by Askey the patients developed shoulder pain and involvement of the hands subsequent to myocardial infarction. The swelling, stiffness, and pain of the hands sometimes preceded the shoulder disability and usually persisted after the disability subsided. The causalgia-like mechanism might explain the phenomena in the hand, but it seems an inadequate explanation for the shoulder pain.

Treatment of this condition is difficult and recovery is usually spontaneous after weeks to months. Passive and active motion of the involved joints should be begun early. Physiotherapy and other usual treatments are of little value.

MISCELLANEOUS

In addition to the conditions discussed, shoulder pain may be produced by local processes or by involvement of the cervical or brachial plexuses, secondary to any of the following: Apical lung tumors (Pancoast syndrome), subclavian arterial aneurysm, tuberculosis of the cervical vertebrae, neurosyphilis, enlarged cervical or axillary lymph nodes, gout, and neurogenic arthropathy (Charcot's disease). Various traumatic lesions of the cervical spine and shoulder girdle may lead to shoulder disability. Referred visceral pain from disease of the gallbladder or diaphragmatic hernia should be considered. Too frequently, despite thorough investigation, the exact cause of the neck and shoulder pain cannot be determined.

2930 South Palm Grove Avenue.

REFERENCES

1. Adson, A. W., and Coffey, J. R.: Cervical rib, method of anterior approach for relief of symptoms by division of scalenus anticus, *Ann. Surg.*, 85:839-857 (June), 1927.
2. Armstrong, J. R.: Supraspinatus syndrome, *Lancet*, 1:94-96 (Jan. 18), 1947.
3. Askey, J. M.: The syndrome of painful disability of the shoulder and hand complicating coronary occlusion, *Am. Heart J.*, 22:1-12 (July), 1941.
4. Aynesworth, K. H.: Cervicobrachial syndrome; discussion of etiology with report of 20 cases, *Ann. Surg.* 111:724-742 (May), 1940.
5. Bauer, J.: Differential diagnosis of angina pectoris, *Ann. West. M. and S.*, 1:4-14 (March), 1947.
6. Caldwell, G. A., Broderick, T. F., and Rose, R. M.: Sympathetic block of the stellate ganglion, *J. Bone and Joint Surg.*, 28:513-520 (July), 1946.

7. Codman, E. A.: The shoulder: Rupture of the supraspinatus tendon and other lesions in or about the subacromial bursa, Boston, The Author, 1934.
8. Donald, J. M., and Morton, B. F.: Scalenus anticus syndrome with and without cervical rib, *Ann. Surg.*, 111:709-723 (May), 1940.
9. Elliott, F., and Kremer, M.: Brachial pain from herniation of cervical intervertebral disc, *Lancet*, 1:48 (Jan. 6), 1945.
10. Falconer, M. A., and Weddell, G.: Costoclavicular compression of the subclavian artery and vein, *Lancet*, 245: 539-543 (Oct. 30), 1943.
11. Foerster, C.: The dermatomes in man, *Brain*, 56:1-39 (March), 1933.
12. Gage, M., and Parnell, H.: Scalenus anticus syndrome, *Am. J. Surg.*, 73:252-268 (Feb.), 1947.
13. Griffith, G. C.: Personal communication.
14. Hawk, W. A.: Spinal compression caused by ecchondrosis of intervertebral fibrocartilage: with review of recent literature, *Brain*, 59:204-224 (June), 1936.
15. Heinbecker, P.: Anatomic and physiologic criteria for surgical relief of cardiac pain, *J. Thorac. Surg.*, 2:517-518 (June), 1933.
16. Imperati, Muscattolini and Rubino: Ruptured intervertebral disk simulating angina, *Foreign Letters, J.A.M.A.*, 133:1030 (April 5), 1947.
17. Jones, F. W.: Variations of the first rib associated with changes in the constitution of the brachial plexus, *J. Anat. and Physiol.*, 45:249-255 (April), 1910.
18. Judovich, B., and Bates, W.: Segmental neuralgia in painful syndromes, F. A. Davis Co., Philadelphia, pp. 100-106, 1944.
19. Judovich, B., Bates, W., and Drayton, W. Jr.: Pain in shoulder and upper extremity due to scalenus anticus syndrome, *Am. J. Surg.*, 63:377-381 (March), 1944.
20. Kabat, H.: Studies in neuromuscular dysfunction: Neostigmine therapy of chronic rheumatoid arthritis and subacromial bursitis, *Pub. Health Rep.*, 59:1635-1650 (Dec. 22), 1944.
21. Kahn, E. A.: Role of the dentate ligaments in spinal cord compression and the syndrome of lateral sclerosis, *J. Neurosurg.*, 4:191-199 (May), 1947.
22. Keyes, D. C., and Compere, E. L.: Normal and pathological physiology of the nucleus pulposus of the intervertebral disc, *J. Bone and Joint Surg.*, 14:897-938 (Oct.), 1932.
23. Leriche, R.: *La chirurgie de la douleur*, The surgery of pain, translated by A. Young, 2nd ed., Paris, 1940, Masson.
24. Libman, E.: Discussion of paper by Askey.³
25. Miller, H. R.: *Angina pectoris*, Baltimore, 1939, Williams and Wilkins Co., p. 130.
26. Murphy, J. B.: A case of cervical rib with symptoms resembling subclavian artery aneurysm, *Ann. Surg.*, 41:399-406 (March), 1905.
27. Nachlas, I. W.: Scalenus anticus syndrome or cervical foraminial compression?, *South. M. J.*, 35:663-667 (July), 1942.
28. Naffziger, H. C., and Boldrey, E. B.: Surgery of the spinal cord, in surgical treatment of the nervous system, ed. by Bancroft, F. W., and Pilcher, C., Philadelphia, J. B. Lippincott Co., 1946, p. 376.
29. Ochsner, A., Gage, M., and Debaquey, M. E.: Scalenus anticus syndrome, *Am. J. Surg.*, 28:669-695 (June), 1935.
30. Raney, R.: Personal communication.
31. Saunders, J. B. de C. M., and Inman, V. T.: The intervertebral disc: A critical and collective review, *Internat. Abs. Surg.*, 69:14-29 (July), 1939.
32. Schlesinger, E. B.: In Combined staff clinic on rheumatoid arthritis, *Am. J. Med.*, 1:688 (Dec.), 1946.
33. Semmes, R. E., and Murphey, F.: The syndrome of unilateral rupture of the sixth cervical intervertebral disc, *J.A.M.A.*, 121:1209-1214 (April 10), 1943.
34. Smith, H. L.: Arm pain due to heart disease, *Surg. Clin. N. A.*, pp. 804-805 (Aug.), 1946.
35. Spurling, R. G., and Scoville, W. B.: Lateral rupture of the cervical intervertebral discs; a common cause of shoulder and arm pain, *Surg. Gyn. and Obst.*, 78:350-358 (April), 1944.
36. Stookey, B.: Compression of the spinal cord due to ventral extradural cervical chondromas, *Arch. Neurol. and Psychiat.*, 20:275-291 (Aug.), 1928.
37. Swank, R. L., and Simeone, F. A.: Scalenus anticus syndrome; types; characterization, diagnosis and treatment, *Arch. Neurol. and Psychiat.*, 51:432-445 (May), 1944.
38. Terry, R. J.: in *Morris' Anatomy*, ed. by J. P. Schaeffer, Phil Blakiston Co., 1942, p. 294.
39. Todd, T. W.: Cervical rib: Factors controlling its presence and its size, its bearing on the morphology and development of the shoulder, *J. Anat. and Physiol.*, 46:244-288 (April), 1912.
40. Todd, T. W.: Posture and the cervical rib syndrome, *Ann. Surg.*, 75:105-109 (Jan.), 1922.
41. Toumey, J. W.: Pain in the neck and shoulder from the viewpoint of the orthopedist, *Lahey Clinic Bull.*, 5:61-64 (Oct.), 1946.
42. Turner, E. L., and Oppenheimer, A.: A common lesion of the cervical spine responsible for segmental neuritis, *Ann. Int. Med.*, 10:427-440 (Oct.), 1936.
43. White, J. C., and Smithwick, R. H.: *Surgery of the autonomic nervous system*, New York, Macmillan Co., 1938.
44. Whiteleather, J. E., Semmes, R. E., and Murphey, F.: Roentgenographic signs of herniation of cervical intervertebral disk, *Radiol.*, 46:213-219 (March), 1946.
45. Wilson, C. L.: Lesions of the supraspinatus tendon, *Arch. Surg.*, 46:307-325 (March), 1943.
46. Wright, I. S.: The neurovascular syndrome produced by hyperabduction of the arms, *Am. Heart J.*, 29:1-19 (Jan.), 1945.

